

Transmission and Mitigation of COVID-19 in Enclosed Spaces

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Abstract

Every day brings new learnings related to COVID-19 that influence decisions, behavior and technology related to health and safety. It is well recognized that COVID-19 or SARS-CoV-2 virus could be spread through touch, large droplets, and small aerosols. The World Health Organization and the U.S. Centers for Disease Control (CDC) have recommended 2 m social distancing. Will this be sufficient to prevent the disease transmission in enclosed spaces?

This lecture reviewed a few well-known cases of COVID-19 transmissions in enclosed spaces, such as restaurants, commercial airplanes, etc. The investigation used computational fluid dynamics (CFD) to analyze some of the cases to reveal the transmission mechanism of COVID-19 aerosols. To prevent further transmission of COVID-19, this study compared a few mitigation methods, including the use of masks, air cleaner, bipolar ionizer, ultraviolet lights, and advanced ventilation systems.

Our research indicated that inhalable aerosols can be transferred to 2 m away but ventilation could bring them further in an enclosed space. In many enclosed spaces, such as airplanes, social distancing is impossible. Mouth covering will help especially with masks. Air cleaners can effectively reduce virus concentration in an enclosed space because of a large amount of clean air. Displacement and personalized ventilation is also effective. Bipolar ionizer and ultraviolet light can inactivate COVID-19 but their costs and efficacy need to be further studied.

Biography of Presenting Author



Qingyan “Yan” Chen is the James G. Dwyer Professor of Mechanical Engineering at Purdue University, USA. He serves also as the Editor-in-Chief of the international journal “*Building and Environment*”. Dr. Chen was the founding co-Principal Director of the Federal Aviation Administration (FAA) Center of Excellence for Airliner Cabin Environment Research from 2004 to 2010.

Dr. Chen earned his B.Eng. in 1983 from Tsinghua University in China and M. Eng. in 1985 and Ph.D. in 1988 from the Delft University of Technology in the Netherlands. He conducted his post-doctoral research as a Research Scientist at the Swiss Federal Institute of Technology (ETH-Zurich) and worked as a Project Manager for TNO in the Netherlands. Before he joined Purdue

University, he was an Associate Professor at the Delft University of Technology and an Assistant Professor and Associate Professor at the Massachusetts Institute of Technology, USA.

Dr. Chen has many other parallel appointments in his career, such as Honorary Professor at RMIT University in Australia, Otto Mönsted Visiting Professor at the Technical University of Denmark, Professorial Fellow at Cardiff University in the UK, Changjiang Chair Professor at Tianjin University in China, Research Fellow at the Chinese Academy of Sciences, New Millennium Yuelu Outstanding Visiting Professor at Hunan University in China, Adjunct Professor at the Harbin Institute of Technology and Xi'an Jiaotong University in China, Visiting Professor at Helsinki University of Technology in Finland and at Tsinghua University in China, and Guest Professor at Tokyo Polytechnic University in Japan and Southeast University, Dalian University of Technology, Soochow University, Guangzhou University, Central South University, and Hunan University in China. In addition, he has co-supervised Ph.D. students from the Eindhoven University of Technology in the Netherlands, the University of Cagliari and the University of Padua in Italy, and Queensland University of Technology in Australia. Dr. Chen's current research topics include indoor environments; aircraft cabin environments; and energy- efficient, healthy, and sustainable building design and analysis. He has received a total funding exceeding US\$24M. He has also published three books, more than 250 journal papers and more than 230 book chapters and conference papers and has been invited to deliver more than 180 lectures internationally. *Google Scholar* shows that his journal publications have been cited by more than 17,000 times and his H-index is 70.

Dr. Chen has received the Distinguished Achievement Award for “individuals who have made substantial contributions to the field of building performance simulation over the course of their careers” from International Building Performance Simulation Association (IBPSA) in 2013, the Oversea Chinese Contribution Award (Creative Talents) for “outstanding achievements in serving China” from All-China Federation of Returned Overseas in 2012, the John Rydberg Gold Medal for “outstanding contribution to the advancement of modelling and measurement of ventilation and air distribution in buildings” from the Scandinavian Federation of Heating, Ventilating and Sanitary Engineering Associations in 2011, and the Willis J. Whitfield Award "for significant contributions to the field of contamination control through numerous published papers, studies, and reports" from the Institute of Environmental Sciences and Technology in 2007. He was nominated for Haihe Friendship Award “in recognition of foreign experts having made outstanding contributions in the city's economic and social development” by Tianjin City, China in 2012. Chen has also received several technical paper and poster awards and Distinguished and Exceptional Service Awards from ASHRAE. He is a recipient of the CAREER award from the National Science Foundation in the United States and is recognized as “Well-Known Oversea Chinese” by the Chinese Academy of Sciences. He is a fellow of the ASHRAE and the International Society of Indoor Air Quality. Before he became the Editor-in-Chief of the Building and Environment journal, he has served as an associate editor of the *HVAC&R Research* journal and has also been a member on the editorial boards of seven other journals.

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